Effect of sugar beet pulp fibre fractions on growth performance, fecal digestibility and digestive physiology in rabbits around weaning

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ABSTRACT – The present study investigated the effect of the different fibre components of sugar beet pulp (SBP) on growth performance and some digestive traits. Four semi-synthetic diets were formulated with similar NDF (33% DM) and protein (16% DM) level. Control diet was formulated to contain the lowest level of soluble fibre (3% DM) and SBP diet the highest (9%). The soluble (pectins) and insoluble fractions of SBP were studied in other two diets (Pectin and InsSBP diets). A total of 136 weanling rabbits (25 d of age) was housed individually, randomly assigned to 4 experimental groups, and fed *ad libitum* with the experimental diets during 10 days after weaning. The type of diet did not affect growth rate and stomach pH. Animals fed with SBP diet showed higher DM and NDF digestibility (4 and 83%, respectively), gain:feed ratio (13%), cecal and total tract weight (13 and 9%) and ileal viscosity (148%) than rabbits fed the Control diet, but lower cecal pH (9%). Pectin diet increased ileal viscosity and decreased the weight of stomach content with respect to SBP diet. Rabbits fed InsSBP diet showed similar results to SBP diet but lower ileal viscosity and cecal pH than those fed Pectin diet. In conclusion, SBP and their soluble and insoluble fractions are well digested in young rabbits. However the soluble and insoluble fibre of SBP produce different effects in the gastrointestinal tract.

Key words: Soluble fibre, Young rabbits, Viscosity, Digestive traits.

INTRODUCTION – The soluble fibre (SF) may be considered as a functional nutrient in rabbit diets as it promotes changes in intestinal microbiota and gut barrier and it decreases mortality (Carabaño *et al*., 2008; Xiccato *et al*., 2011). However, the mechanism by which SF regulates these effects is not clear. In rabbit diets, sugar beet pulp (rich in pectins) is the preferred raw material to increase dietary SF level. However, the physical and chemical complexity of soluble polysaccharides and their interactions with other components of the diet make it difficult to define or isolate the single effects of SF components. In consequence, the aim of this work was to investigate the effect of the different fibre fractions (soluble and insoluble) of sugar beet pulp (SBP) on growth performance and at the gastro-intestinal tract level.

MATERIALS AND METHODS – Four semi-synthetic diets were formulated with similar level of NDF (33% DM) and crude protein (16% DM). Control and SBP diets were formulated to contain two levels of SF (3 and 9% DM). The soluble (pectins, Betapec RU 301) and insoluble fractions of SBP (obtained by washing SBP in hot water with NDF solution) were studied by substituting starch or insoluble fibre in the Control diet and obtaining Pectin and InsSBP diets, respectively (Table 1). A total of 136 weanling rabbits of both sexes was blocked by litter at 25 d of age (LW 445±79 g) and randomly assigned to the 4 experimental diets. Animals were housed individually and fed *ad libitum* with the experimental diets during 10 days after weaning. During this period, average feed intake, weight gain and mortality were measured. Fecal digestibility was determined by total collection of hard feces from 31 to 34 d in 11 rabbits/diet. At 35 d, rabbits were slaughtered from 19:00 to 21:00 h and the weight of full organs of digestive tract, pH of stomach and cecum and ileal viscosity were recorded. AOAC (2000) procedures were used to determine the concentrations of DM, CP, and TDF (985.29). Dietary NDF, ADF, and ADL were determined sequentially (Mertens, 2002). The results were analyzed as a completely randomized block design, with the type of diet as the main source of variation and the litter as a block, using the GLM procedure of SAS. Weaning weight was included as covariate. Means were compared using a *t*-test.

Table 1 – Composition of the experimental diets.

	Control	Pectin	SBP	InsSBP
Ingredients				
Wheat straw	18.0	18.0	11.1	11.1
Sunflower hulls	18.0	18.0	11.1	11.1
Sugar beet pulp	—	—	26.0	—
Insoluble sugar beet pulp[1]	—	—	—	14.0
Pectin[2]	—	6.0	—	—
Wheat starch	36.0	30.0	26.7	36
Others [3]	28	28	26.1	26.8
Chemical composition, % DM				
CP	16.2	15.9	16.2	16.1
NDF	32.4	32.1	33.0	32.5
ADF	19.8	19.5	20.2	19.5
ADL	4.84	4.38	4.38	3.34
Soluble fibre (TDF-NDF)	3.7	8.4	9.7	3.0

[1]Residue after washing Sugar beet pulp (SBP) in hot NDF solution, filtration and dried. [2]Pectin extracted from SBP Betapec®. [3]Others in %: Casein 15.6–14.4, Arbocel 5.0-3.1, Saccharose 1.5 (InsSBP diet), Alfalfa hay-Yb 0.5, Soy bean oil 3.75, Sodium chloride 0.7, Calcium phosphate 0.9, Calcium carbonate 0.9, DL-methionine 0.1, Exal 0.25, Mineral-vitamin premix 0.5.

RESULTS AND CONCLUSIONS – The type of diet did not affect growth rate and stomach pH (Table 2). Nor mortality or health problems were detected. Control and InsSBP diets showed the lowest and highest ($P<0.05$) DM digestibility, respectively, showing Pectin and SBP diets intermediate values. DM digestibility of Pectin diet was not different from the Control diet. Since these diets only differed on the substitution of starch for pectins, this suggests a similar digestibility of these two chemical components. The NDF digestibility of these two diets was low, in agreement with previous results (García *et al*., 1999). The inclusion in the diet of SBP or their insoluble fibre fraction increased ($P<0.05$) NDF digestibility, in accordance with previous results (Gidenne, 1987).We found that the higher dietary DM digestibility, the lower feed intake and the higher gain:feed ratio. The rabbits fed with SBP and InsSBP diets showed higher ($P<0.05$) cecal (10%) and total digestive tract (7.2%) weight than those fed with control diet. Pectin diet also increased cecal weight compared to control diet, whereas reduced the weight of stomach. These results are in agreement with literature and explain carcass yield decrease in animals fed with diets high in SBP (García *et al*., 1993, Xiccato *et al*., 2011). When we compared SBP diet with their soluble or insoluble fractions (pectins and InsSBP diets), the insoluble fraction seems to be the main responsible of the high total digestive tract weight. The inclusion of SBP or their fractions increased the ileal viscosity (2.6 times on average, P<0.05) and decreased the cecal pH. Pectin diet showed higher viscosity than InsSBP diet; SBP diet resulted in intermediates figures. On the contrary, InsSBP diet lowered the cecal pH compared to Pectin diet. This effect is well correlated with NDF digestibility of diets. In conclusion, SBP and their soluble and insoluble fractions are well digested in young rabbits and permit to maintain comparable growth rates. However, the soluble and insoluble fractions of SBP produce different effects at the gastrointestinal tract.

Table 2 – Effect of type of diet on growth performance, some digestive traits and digestibility in rabbits fed experimental diets from weaning (25 d) to 35 days of age.

	Control	Pectin	SBP	InsSBP	rsd[1]	Diet
Growth performance (25-35 d)						
DM intake, g/d	64.8^{a}	63.0^{a}	59.0^{ab}	56.7^{b}	7.29	0.036
Daily weight gain, g/d	37.2	36.7	38.8	36.9	11.6	0.64
Gain: Feed, g/g	0.584^{b}	0.595^{b}	0.662^{a}	0.665^{a}	0.082	0.001
Weight of full organs, % BW						
Total digestive tract	21.5^{b}	21.0^{b}	23.4^{a}	22.7^{a}	1.97	0.001
Stomach	6.60^{a}	4.79^{b}	6.80^{a}	6.74^{a}	1.15	0.001
Caecum	6.13^{b}	6.60^{ab}	6.94^{a}	6.73a	0.99	0.008
Ileal viscosity, mPa·s (log)	3.06^{c}	9.77^{a}	7.58^{ab}	6.40^{b}	0.434	0.001
pH of stomach	1.82	1.71	1.67	1.49	0.37	0.067
pH of cecum	6.23^{a}	5.94^{b}	5.67^{bc}	5.63^{c}	0.42	0.001
Fecal digestiblity, %						
DM	66.4^{c}	67.8^{cb}	69.0^{b}	72.6^{a}	2.46	0.001
NDF	14.3^{c}	18.0^{c}	26.2^{b}	32.7^{a}	4.77	0.001

[1]n=34 per group, except for ileal viscosity and digestibility where n=16 and 11, respectively. [a-c] Mean values in the same row with a different superscript differ, *P*<0.05.

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